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Title : A Method for Manufacturing A
Semiconductor Thin Film Crystal Layer

Specifications

1. Title of the Invention

A Method for Manufacturing A Semiconductor Thin Film
Crystal Layer

2. Claims

(1) A method for manufacturing a semiconductor thin film crystal layer comprising a step for forming an insulation layer wherein an opening portion is arranged on part of a monocrystal silicon layer, a step for applying a metallic film on the whole surface of the above silicon so that a metallic silicide does epitaxial growth, a step for siliciding the metallic film at the above opening portion by heating process so as to a metallic silicide film, a step for removing a metallic film which does not react yet by etching, and a step for applying a silicon thin film over the whole surface, and a step for causing epitaxial growth of the above silicon thin film from the above metallic silicide film by beam annealing.

(2) A method for manufacturing a semiconductor thin film crystal layer set forth in claim 1, wherein the above monocrystal silicon layer is a monocrystal silicon substrate.

(3) A method for manufacturing a semiconductor thin film crystal layer set forth in claim 1, wherein the above monocrystal silicon layer is a monocrystal silicon thin film layer formed on a above

insulating film.

(4) A method for manufacturing a semiconductor thin film crystal layer set forth in claim 1, wherein the above metallic film is made of nickel, platinum, vanadium, or cobalt.

(5) A method for manufacturing a semiconductor thin film crystal layer set forth in claim 1, wherein an electron beam or a laser beam is employed as the method of the above beam annealing.

3. Detailed Description of the Invention

[Field of the Invention]

The present invention relates to a technology to manufacture a monocrystal silicon thin film layer on an insulation film, and more specifically, the present invention relates to a method for manufacturing a semiconductor thin film crystal layer employing beam annealing method.

[Prior Art and the Problem]

Recent years, the development of a technology for forming a monocrystal thin film layer on an insulating film by annealing by use of an electron beam or a laser beam, that is, what is called SOI technology, has been conducted widely. And the realization of a 3-dimensional IC which form elements are in multiple layers by use of this technology has attracted much attention.

In order to realize a 3-dimensional IC, for example, a 2-layer structure element, after an interlayer insulating film is formed on an element (lower layer element) formed on the surface of a monocrystal silicon substrate, a monocrystal silicon thin film layer formed by SOI technology is formed. Thereafter, an element (upper layer element) is formed on the monocrystal silicon thin film layer, thus a 2-layer structure element is realized.

However, in this kind of conventional methods, there have been the following problems. Namely, a silicon thin film layer for forming an upper layer element is formed by epitaxial growth using a monocrystal silicon substrate exposed at an opening portion arranged on an insulating film as a seed, but when the thickness of an insulating film at an opening portion is around $2\mu\text{m}$, in liquid phase epitaxial growth of an upper layer silicon layer, for example, by using electron beam annealing, silicon which melt around the opening portion will flow into a convex portion at the opening

portion. As a consequence, the thickness of silicon layer around the opening portion is reduced, and further, silicon film is apt to vapor at beam annealing. And since the thermal conductivity of silicon is better than that of an insulating film, the temperature of silicon around the opening portion becomes lower than that of silicon on an insulation film at beam annealing, as a result, it is impossible to carry out preferable annealing, which have been problems with the conventional methods according to the prior art.

[Object of the Invention]

The present invention has been made in consideration of the above problems with the conventional methods according to the prior art, accordingly, one object of the present invention is to provide a method for manufacturing a semiconductor thin film crystal layer that prevents the reduction of thickness of silicon film and the evaporation of silicon around opening portion, and enables to form a monocrystal silicon thin film layer which has quality on an insulation film, and is suitable for the manufacturing of multiple layer elements.

[Abstract of the Invention]

The main point of the present invention lies in that a metallic silicide is embedded in advance in an opening portion which causes the reduction of thickness of silicon film and the evaporation of silicon.

Namely, the present invention, in a method for forming a monocrystal silicon thin film layer on an insulating film, may is a method, wherein an insulating film which an opening portion is arranged on a part of a monocrystal silicon layer is formed, after that, a metallic film is adhered on the whole surface of the above silicon so that a metallic silicide does epitaxial growth on the above silicon layer, thereafter a metallic silicide at the above opening portion is silicified to form a metallic silicide film by heat treatment, thereafter a metallic film which does not react is removed by etching, thereafter a silicon thin film is adhered over the whole surface, and thereafter epitaxial growth of the above silicon thin film is made from the above metallic silicide film by beam annealing.

[Effect of the Invention]

According to the present invention, since a metallic silicide is embedded in an opening portion (seed portion), it is possible to restrict the reduction of the thickness of a silicon film and the evaporation of silicon around opening portion at beam annealing to a great extent. Moreover, it is possible to decrease the difference between the temperature of a silicon thin film layer at an opening portion and that of a silicon thin film layer on an insulating film by the presence of the above metallic silicide. As a consequence, it is possible to form a monocrystal silicon thin film layer which has quality on an insulating film, thus the present invention is extremely useful for the manufacturing of a 3-dimensional IC and so on.

[Embodiment]

In reference to the embodiment shown in the attached drawings, the present invention is explained in details hereinafter.

FIG.1 through FIG.5 are cross sections showing manufacturing processes of a semiconductor thin film crystal layer relating to embodiment of the present invention. First, as shown in FIG.1, an oxide film (insulating film) $2\mu\text{m}$ thick is formed on a monocrystal silicon substrate (monocrystal silicon layer) 1, which plane is (100) plane direction, and an opening portion 3 is formed on a part of the oxide film 2. Thereafter, as shown in FIG.2, a nickel film (metallic film) 4 $1.5\mu\text{m}$ thick is formed on the whole surface. Thereafter, heat treatment at 450°C is carried out under nitrogen atmosphere, and as shown in FIG.3, a nickel silicide film (metallic silicide film) 5 is formed on the opening portion 3.

Then, as shown in FIG.4, a nickel film 4 which does not react is removed with aqua regia, and thereafter heat treatment is carried out at 800°C , and epitaxial growth of NiSi_2 is conducted. In this status, the surface of the sample is in almost flat condition. Thereafter, as shown in FIG.5, a polycrystal silicon film (silicon thin film) 6 6000\AA thick is adhered on the whole surface by low pressure CVD method, and further a protective insulating film 7 2000\AA thick is adhered by atmospheric pressure CVD method. Thereafter, a pseudo-linear electron beam which melting width is $1\mu\text{m}$ is made to scan, and thereby monocrystal growth of the

silicon film is carried out using NiSi_2 (nickel silicide) at the opening portion 3 as seed. At this moment, since the under surface of the polycrystal silicon thin film 6 is flat, there is no problem that melt silicon will flow into the opening portion 3 as seen in the conventional art, and further the reduction of silicon film thickness around the opening portion and the evaporation of silicon are restricted to a great extent.

[Effect of the Invention]

As mentioned heretofore, according to the present invention, it is possible to form a monocrystal silicon thin film layer on the oxide film 2, and also to restrict the reduction of silicon film thickness around the seed-opening portion 3 and the evaporation of silicon. And further, since the nickel silicide film 5 is embedded in the opening portion 2, in beam annealing, it is possible to make the temperature of silicon on the opening portion 2 closer to that of silicon on the insulation film 2, and so it has effect on the growth of quality crystal. Moreover, since a nickel silicide film 5 is embedded in the opening portion 3, it is possible to make the connecting resistance between upper and lower layers extremely small. This is extremely effective for multiple layer structure elements.

And since as a means to embed the nickel silicide in the opening portion 2, the step which makes the nickel film 4 silicide is employed, the process is simple. Namely, though selective growth method may be employed as a means to embed the nickel silicide film 5, the crystal property of film which is formed in this case is bad, and conditions for selective growth are extremely bad. On the other hand, in the present invention, it may be realized easily only by use of an etching liquid which has selectivity for the nickel film and the nickel silicide film.

By the way, the present invention is not limited only to the preferred embodiment mentioned above. For example, the above metallic film is not limited to nickel, but platinum, paradium, cobalt or so may be employed, by selecting the face azimuth of the lower layer substrate. And in the place of an electron beam, a laser beam may be employed, and further, annealing method by use of a carbon heater may be also employed. And the silicon layer at lower layer is not limited to a monocrystal silicon substrate, but a

monocrystal silicon film formed on an insulation film may be employed. Further, the present invention is not limited to a 2-layer structure, but may be applied to a 3 or more-layer structure. And the silicon thin film to be formed on an insulation film is not limited to polycrystal silicon, but noncrystal silicon may be used. This invention may be embodied in several forms without departing from the gist of essential characteristics thereof.

4. Brief Description of the Drawings

FIG.1 through FIG.5 are cross sectional views showing manufacturing processes of a semiconductor thin film crystal layer according one preferred embodiment under the present invention.

- 1 Monocrystal silicon substrate (monocrystal silicon layer)
- 2 Oxide film (insulating film)
- 3 Opening portion
- 4 Nickel film (metallic film)
- 5 Nickel silicide film (metallic silicide film)
- 6 Polycrystal silicon film (silicon thin film)
- 7 Protective insulation film

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[FIG.1]

[FIG.2]

[FIG.3]

[FIG.4]

[FIG.5]